PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

BUZZI, Franco
BUZZI NOTARO & ANTONIELLI D'OULX
SRL
Corso Fiume, 6
10133 Torino
ITALIE

PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	07.05.2001

Applicant's or agent's file reference	IMPORTANT NOTIFICATION
BWO3461-MM	

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IT99/00422	27/12/1999	22/01/1999

Applicant
PELLEGRINO, Luigi

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Lindquist, P Tel. +49 89 2399-2324

Form PCT/IPEA/416 (July 1992)

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
BWO3461-MM		
International application No.	International filing date *(day month year)*	Priority date *(day month year)*
PCT/IT99/00422	27/12/1999	22/01/1999
International Patent Classification (IPC) or national classification and IPC F01N3/08		
Applicant PELLEGRINO, Luigi		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 9 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
18/08/2000	07.05.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Kolland, U Telephone No. +49 89 2399 8166

Form PCT IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IT99/00422

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

4-16	as originally filed			
1,2,2a,3	as received on	04/12/2000	with letter of	28/11/2000

Claims, No.:

1-23	as received on	04/12/2000	with letter of	28/11/2000

Drawings, sheets:

1/3-3/3	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   ☐ the language of publication of the international application (under Rule 48.3(b)).
   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.
   ☐ filed together with the international application in computer readable form.
   ☐ furnished subsequently to this Authority in written form.
   ☐ furnished subsequently to this Authority in computer readable form.
   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

☐ the description, pages:

☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-23
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-23
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-23
	No:	Claims	

2. Citations and explanations
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Claim 1

The most relevant prior art appears to be document EP-A-0 511 415 (=D1). This document discloses a device for reducing atmospheric pollution by exhaust gas comprising the features of the first part of claim 1.

The remaining feature of claim 1, which defines that the *outer chamber* has an annular section *decreasing in the flow direction of the exhaust gas*, is neither known from nor rendered obvious by the available prior art.

It is also credible that such an arrangement provides a longer working life compared to the apparatus suggested in the prior art, because the characterising feature provides a substantially uniformal gas pressure on the outer surface of the scrubbing means (as stated by the applicant in the letter of 28.11.2000).

The industrial applicability is selfevident.

The subject-matter of claim 1 therefore appears to meet the criterion set forth in Article 33(1) PCT.

Claims 2 to 23

The dependent claims 2 to 23 contain modifications of the inventive idea embodied in claim 1 and appears also to meet the requirements of Article 33(1) PCT.

Re Item VIII

Certain observations on the international application

1. The statement in the description on page 10, line 19- page 11, line 6 and page 16, lines 16-18 imply that the subject-matter for which protection is sought may be different to that defined by the claims, thereby resulting in lack of clarity (Article 6 PCT) when used to interpret them (see also the PCT Guidelines, III-4.3a).

2. From the disclosure of the application the *scrubbing means* can not be regarded as a *catalizer cartridge* (as stated in the letter of 28.11.2000).

09/889773
JC18 Rec'd PCT/PTO 2 0 JUL 2001

DEVICE FOR REDUCING ATMOSPHERIC POLLUTION BY EXHAUST GAS

TECHNICAL FIELD

The present invention relates to a device for reducing atmospheric pollution by exhaust gas. In particular, the present invention may be used to advantage, though not exclusively, for treating exhaust gas produced by any type of internal combustion engine diesel or Otto cycle, vehicle-mounted or forming part of a fixed installation-or by heating boilers forming part of industrial or civil installations.

BACKGROUND ART

As is known, the exhaust gas produced by internal combustion engines, particularly diesel engines, contains numerous harmful substances, such as unburnt hydrocarbons, particulate, nitrogen and carbon oxides, etc.

Numerous systems and devices have been designed to reduce the atmospheric pollution produced by internal combustion engine exhaust gas.

Such systems and devices normally comprise a hollow casing having an inlet at one end for the unpurified exhaust gas, and an outlet at the other end for the purified exhaust gas; and scrubbing means interposed between the inlet and outlet.

The scrubbing means used may comprise, for example, a tubular cartridge housed inside the casing and defined by a tubular pad containing purifying mineral fibers

and supported by a basket defined by two coaxial tubular bodies of rigid netting between which the pad is interposed.

In cartridge devices of the above type, the unpurified exhaust gas is fed into the cartridge, expands radially through the cartridge and is purified by the mineral fibers inside, comes out, purified, through the outer lateral surface of the cartridge, and is then conveyed to the outlet of the device.

Though particularly advantageous in terms of cost and elimination of contaminating substances, in certain applications, cartridge devices in which the exhaust gas is fed inside the cartridge have several drawbacks preventing maximum benefit of such advantages. In particular, in applications involving exhaust gas with a high degree of kinetic energy, expansion of the exhaust gas through the cartridge has been found to be fairly aggressive, thus subjecting the pad to far greater mechanical stress and, hence, wear as compared with normal applications.

In such applications, the average working life of the cartridge-by which is meant the length of time the efficiency of the cartridge is such as to conform with international standards governing the emission of contaminating substances-is therefore considerably shorter than in normal applications, thus resulting in higher costs to continually replace the cartridge.

EP-A-511415 discloses a device for the filtration of exhaust gases from internal combustion engines having a housing containing one or more inflow openings and one

or more outflow openings, and devices arranged in the housing for taking the exhaust gas stream with low restrictions from the inflow opening through an expansion chamber, whose cross-section is several times greater than the flow cross-section of the inflow opening.

DISCLOSURE OF INVENTION

It is an object of the present invention to provide a device for reducing atmospheric pollution by internal combustion engine exhaust gas, and which provides for a long average working life in any type of application.

According to the present invention, there is provided a device for reducing atmospheric pollution by exhaust gas, according to claim 1.

efficiency of the cartridge is such as to conform with international standards governing the emission of contaminating substances - is therefore considerably shorter than in normal applications, thus resulting in higher costs to continually replace the cartridge.

DISCLOSURE OF INVENTION

It is an object of the present invention to provide a device for reducing atmospheric pollution by internal combustion engine exhaust gas, and which provides for a long average working life in any type of application.

According to the present invention, there is provided a device for reducing atmospheric pollution by exhaust gas, comprising a casing having an inlet for the unpurified exhaust gas, and an outlet for the purified exhaust gas; and scrubbing means housed in said casing, interposed between said inlet and said outlet, and defining an inner chamber and, together with said casing, an outer chamber surrounding said scrubbing means; characterized by comprising first connecting means for connecting said outer chamber to said inlet; and second connecting means for connecting said inner chamber to said outlet.

BRIEF DESCRIPTION OF DRAWINGS

A preferred, non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a longitudinal section of a device for reducing atmospheric pollution by exhaust gas, in

4) A device (1; 1') as claimed in Claim 3, characterized in that said first portion (18a; 18a') of said first inlet conduit (18; 18') has a substantially constant exhaust gas passage section.

5) A device (1; 1') as claimed in Claim 4, characterized in that the exhaust gas passage section of said first portion (18a; 18a') of said first inlet conduit (18; 18') is substantially equal to the exhaust gas passage section defined by said inlet (4).

6) A device (1; 1') as claimed in any one of Claims 3 to 5, characterized in that said first portion (18a; 18a') of said first inlet conduit (18; 18') is defined by a pair of conical walls (10b, 16a; 10b, 16a') increasing in diameter towards said outer chamber (34) and converging with each other towards the outer chamber (34).

7) A device (1; 1') as claimed in any one of Claims 3 to 6, characterized in that said first inlet conduit (18; 18') also comprises a second portion (18b; 18b') located downstream from said first portion (18a; 18a') and having a substantially constant exhaust gas passage section.

8) A device (1) as claimed in Claim 7, characterized in that the exhaust gas passage section of said second portion (18b) of said first inlet conduit (18) is substantially equal to the exhaust gas passage section of said first portion (18a).

CLAIMS

1) A device (1; 1'; 1"; 1"') for reducing atmospheric pollution by exhaust gas, comprising a casing (2) having an inlet (4; 4", 4"') for the unpurified exhaust gas, and an outlet (6) for the purified exhaust gas; and scrubbing means (8) housed in said casing (2), interposed between said inlet (4; 4" ; 4"') and said outlet (6), and defining an inner chamber (36) and, together with said casing (2), an outer chamber (34) surrounding said scrubbing means (8); comprising first connecting means (18; 18' ; 54,18") for connecting said outer chamber (34) to said inlet (4; 4" ; 4'""); and second connecting means (14-) for connecting said inner chamber (36) to said outlet (6),
characterized in that said outer chamber (34) has an annular section decreasing in the flow direction of the exhaust gas.

2) A device (1; 1') as claimed in Claim 1, characterized in that said first connecting means comprise an annular-section first inlet conduit (18; 18').

3) A device (1; 1') as claimed in Claim 2, characterized in that said first inlet conduit (18; 18') comprises at least a first portion (18a; 18a') having transverse dimensions increasing towards said outer chamber (34).

9) A device (1') as claimed in Claim 7, characterized in that the exhaust gas passage section of said second portion (18b') of said first inlet conduit (18') is greater than the exhaust gas passage section of said first portion (18a').

10) A device (1; 1') as claimed in any one of Claims 7 to 9, characterized in that said second portion (18b; 18b') of said first inlet conduit (18; 18') is defined by a pair of cylindrical walls (10c, 16b; 10c, 16b') of substantially constant diameter.

11) A device (1) as claimed in any one of Claims 3 to 8, characterized in that said first inlet conduit (18) also comprises a third portion (18c) located downstream from said first portion (18a) and having an increasing exhaust gas passage section.

12) A device (1) as claimed in Claim 11, characterized in that said third portion (18c) of said first inlet conduit (18) is defined by a cylindrical outer wall (10c) and by a conical inner wall (16c).

13) A device (1"; 1"') as claimed in Claim 1, characterized in that said first connecting means (54, 18") comprise an exhaust gas expansion chamber (54).

14) A device (1"; 1"') as claimed in Claim 13, characterized in that said first connecting means (54, 18") also comprise an annular-section second inlet

conduit (18") interposed between said expansion chamber (54) and said outer chamber (34).

15) A device (1"; 1"') as claimed in Claim 14, characterized in that said second inlet conduit (18") comprises at least a first portion (18a") having a substantially constant exhaust gas passage section.

16) A device (1"; 1"') as claimed in Claim 15, characterized in that the exhaust gas passage section of said first portion (18a") of said second inlet conduit (18") is substantially equal to the exhaust gas passage section defined by said inlet (4" ; 4"').

17) A device (1"; 1"') as claimed in Claim 15 or 16, characterized in that said first portion (18a") of said second inlet conduit (18") is defined by a pair of cylindrical walls (10a", 16a") of substantially constant diameter.

18) A device (1"; 1"') as claimed in any one of Claims 15 to 17, characterized in that said second inlet conduit (18") also comprises a second portion 18b") located downstream from said first portion (18a") and having an increasing exhaust gas passage section.

19) A device (1"; 1"') as claimed in Claim 18, characterized in that said second portion (18b") of said second inlet conduit (18") is defined by a cylindrical outer wall (10a") and by a conical inner wall (16b").

20) A device (1") as claimed in any one of Claims 13 to 19, characterized in that said casing (2) extends substantially along a first axis (A), and said inlet (4") has a second axis (B) substantially parallel to said first axis (A).

21) A device (1"') as claimed in any one of Claims 13 to 19, characterized in that said casing (2) extends substantially along a first axis (A), and said inlet (4"') has a further axis (C) crosswise to said first axis (A).

22) A device (1"') as claimed in Claim 21, characterized in that said further axis (C) is perpendicular to said first axis (A).

23) A device (1"') as claimed in Claim 21 or 22, characterized in that said further axis (C) is skew with respect to said first axis (A).

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(71)(72) Applicant and Inventor: PELLEGRINO, Luigi [IT/IT]; Via Orperio, 42, I-10090 Rivalba (IT).

(74) Agents: JORIO, Paolo et al.; Studio Torta S.r.l., Via Viotti, 9, I-10121 Torino (IT).

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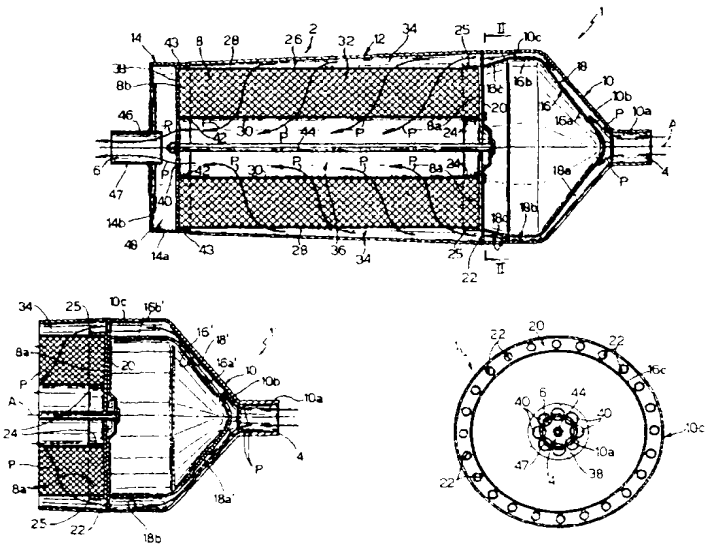

(57) Abstract

The device for reducing atmospheric pollution by exhaust gas has a cylindrical casing (2) in turn having an inlet (4) for the unpurified exhaust gas and an outlet (6) for the purified exhaust gas; a tubular scrubbing cartridge (8) housed inside the casing (2), interposed between the inlet (4) and the outlet (6), and defining a cylindrical inner chamber (36) and, together with the casing (2), an annular-section outer chamber (34) surrounding the scrubbing cartridge (8); an annular-section inlet conduit having transverse dimensions increasing towards the outer chamber (conical shape) (18) connecting the outer chamber (34) to the inlet (4); and a cup-shaped body (14) connecting the inner chamber (36) to the outlet (6), so as to define an inward exhaust gas purifying path through the scrubbing cartridge (8).

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DEVICE FOR REDUCING ATMOSPHERIC POLLUTION BY EXHAUST GAS

TECHNICAL FIELD

The present invention relates to a device for reducing atmospheric pollution by exhaust gas.

In particular, the present invention may be used to advantage, though not exclusively, for treating exhaust gas produced by any type of internal combustion engine - diesel or Otto cycle, vehicle-mounted or forming part of a fixed installation - or by heating boilers forming part of industrial or civil installations.

BACKGROUND ART

As is known, the exhaust gas produced by internal combustion engines, particularly diesel engines, contains numerous harmful substances, such as unburnt hydrocarbons, particulate, nitrogen and carbon oxides, etc.

Numerous systems and devices have been designed to reduce the atmospheric pollution produced by internal combustion engine exhaust gas.

Such systems and devices normally comprise a hollow casing having an inlet at one end for the unpurified

exhaust gas, and an outlet at the other end for the purified exhaust gas; and scrubbing means interposed between the inlet and outlet.

The scrubbing means used may comprise, for example, a tubular cartridge housed inside the casing and defined by a tubular pad containing purifying mineral fibers and supported by a basket defined by two coaxial tubular bodies of rigid netting between which the pad is interposed.

In cartridge devices of the above type, the unpurified exhaust gas is fed into the cartridge, expands radially through the cartridge and is purified by the mineral fibers inside, comes out, purified, through the outer lateral surface of the cartridge, and is then conveyed to the outlet of the device.

Though particularly advantageous in terms of cost and elimination of contaminating substances, in certain applications, cartridge devices in which the exhaust gas is fed inside the cartridge have several drawbacks preventing maximum benefit of such advantages.

In particular, in applications involving exhaust gas with a high degree of kinetic energy, expansion of the exhaust gas through the cartridge has been found to be fairly aggressive, thus subjecting the pad to far greater mechanical stress and, hence, wear as compared with normal applications.

In such applications, the average working life of the cartridge - by which is meant the length of time the

efficiency of the cartridge is such as to conform with international standards governing the emission of contaminating substances - is therefore considerably shorter than in normal applications, thus resulting in higher costs to continually replace the cartridge.

DISCLOSURE OF INVENTION

It is an object of the present invention to provide a device for reducing atmospheric pollution by internal combustion engine exhaust gas, and which provides for a long average working life in any type of application.

According to the present invention, there is provided a device for reducing atmospheric pollution by exhaust gas, comprising a casing having an inlet for the unpurified exhaust gas, and an outlet for the purified exhaust gas; and scrubbing means housed in said casing, interposed between said inlet and said outlet, and defining an inner chamber and, together with said casing, an outer chamber surrounding said scrubbing means; characterized by comprising first connecting means for connecting said outer chamber to said inlet; and second connecting means for connecting said inner chamber to said outlet.

BRIEF DESCRIPTION OF DRAWINGS

A preferred, non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a longitudinal section of a device for reducing atmospheric pollution by exhaust gas, in

accordance with a first embodiment of the present invention;

Figure 2 shows a section along line II-II in Figure 1;

Figure 3 shows a partial longitudinal section of a device for reducing atmospheric pollution by exhaust gas, in accordance with a second embodiment of the present invention;

Figure 4 shows a longitudinal section of a device for reducing atmospheric pollution by exhaust gas, in accordance with a third embodiment of the present invention;

Figure 5 shows a section along line V-V in Figure 4;

Figure 6 shows a cross section of a device for reducing atmospheric pollution by exhaust gas, in accordance with a fourth embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Figures 1 and 2 show a device for reducing atmospheric pollution by exhaust gas, in accordance with a first embodiment of the present invention.

The device, indicated as a whole by 1, is of the type comprising a hollow, elongated casing 2 having an axis A and, at opposite axial ends, a circular-section inlet 4 for unpurified exhaust gas, and a circular-section outlet 6 for purified exhaust gas; and a tubular cartridge 8 fitted coaxially inside casing 2 and of an outside diameter greater than those of inlet 4 and outlet

6.

Casing 2 comprises three axially connected bodies: a substantially funnel-shaped first end body 10; a substantially truncated-cone-shaped intermediate body 12 housing cartridge 8; and a substantially cup-shaped second end body 14.

A substantially cup-shaped guide body 16 is fitted coaxially inside first end body 10, and defines, with first end body 10, a first annular-section gap communicating with inlet 4 and defining an inlet conduit 18 for the unpurified exhaust gas.

More specifically, first end body 10 comprises a substantially cylindrical first portion 10a defining inlet 4 of the device; a substantially truncated-cone-shaped second portion 10b extending integrally and increasing in diameter from first portion 10a; and a substantially cylindrical third portion 10c extending integrally from second portion 10b.

Guide body 16 comprises a substantially conical first portion 16a internally facing truncated-cone-shaped second portion 10b of first end body 10; a substantially cylindrical, larger-diameter second portion 16b extending integrally from first portion 16a and facing an initial portion of third portion 10c of first end body 10; and a truncated-cone-shaped third portion 16c extending integrally from second portion 16a, facing an end portion of third portion 10c of first end body 10, and decreasing in diameter towards intermediate body 12.

More specifically, truncated-cone-shaped second portion 10b of first end body 10 and conical first portion 16a of guide body 16 converge towards intermediate body 12 so as to define an annular-section exhaust gas passage, which is perpendicular to the flow direction of the exhaust gas, is substantially constant along the whole length of portions 10b, 16a, and is substantially equal to the exhaust gas passage section defined by inlet 4, so as to produce no load losses or noticeable counterpressures.

Preferably, the annular-section exhaust gas passage defined by portions 10b, 16a is 80% to 120% of the passage section defined by inlet 4.

In the flow direction of the exhaust gas from inlet 4 to outlet 6, inlet conduit 18 therefore comprises an initial portion 18a - defined by truncated-cone-shaped portion 10b and conical portion 16a - in which the exhaust gas passage section is substantially constant, is equal to the passage section defined by inlet 4, and has an increasing mean radius, measured with respect to axis A; an intermediate portion 18b - defined by cylindrical portions 10c, 16b - in which the gas passage section is substantially constant, is equal to the passage section defined by portions 10b, 16a, and has a substantially constant mean radius; and an end portion 18c - defined by cylindrical portion 10c and truncated-cone-shaped portion 16c - in which the gas passage section increases and has a decreasing mean radius.

Between first end body 10 and intermediate body 12, a first disk-shaped element 20 of a diameter close to that of first end body 10 is mounted coaxially, and has, on a peripheral annular portion located at the end portion of inlet conduit 18, a number of angularly equally spaced through holes 22 through which the exhaust gas flows from inlet conduit 18 to intermediate body 12.

First disk-shaped element 20 supports coaxially a projecting inner locating collar 24 and a projecting outer locating collar 25, which extend inwards of intermediate body 12, and in which is inserted a first end portion 8a of cartridge 8.

More specifically, the outer locating collar 25 is located at a radially inner annular portion of first disk-shaped element 20 with respect to holes 22; and the inner locating collar 24 is located at an inner annular portion of first disk-shaped element 20.

Intermediate body 12 extends along an extension of first end body 10, and decreases in diameter towards second end body 14.

Intermediate body 12 houses tubular cartridge 8, which comprises a basket 26 - defined by an outer and an inner tubular rigid metal net 28, 30, both coaxial with axis A and preferably formed by stretching high-temperature-resistant stainless steel sheet - and a tubular pad 32 interposed between nets 28, 30.

The outer net 28 is smaller in diameter than the minimum diameter of intermediate body 12, and defines,

together with intermediate body 12, a second annular-section gap in turn defining an outer collecting chamber 34 containing, in use, the unpurified exhaust gas.

More specifically, outer collecting chamber 34 surrounds the whole of cartridge 8, is located coaxially along an extension of inlet conduit 18, communicates with inlet conduit 18 through holes 22, and has an exhaust gas passage section gradually decreasing in the flow direction of the gas.

The inner net 30, on the other hand, defines a cylindrical inner collecting chamber 36 containing, in use, the purified exhaust gas fed radially through pad 32.

Pad 32 comprises a braid of woven threadlike material; and purifying mineral fibers (not shown in detail), e.g. pure silica. The braid and the purifying minerals fibers are wound in a spiral to define, between inlet 4 and outlet 6, substantially alternating layers of threadlike material and mineral fibers.

More specifically, the braid is defined by a number of elastically deformable free meshes, conveniently formed by mechanically weaving stainless steel wire particularly suitable for resisting high temperatures such as that of internal combustion engine exhaust gas.

Second end body 14 comprises a cylindrical first portion 14a connected to intermediate body 12; and an end wall 14b having an axial through hole 46 in which is inserted a cylindrical element 47 extending outwards and

defining outlet 6 of device 1.

A second disk-shaped element 38 is fitted coaxially and in sliding and sealed manner inside second end body 14, is positioned parallel to and a distance from end wall 14b of second end body 14, and has, on an inner annular portion located at inner collecting chamber 36, a number of angularly equally spaced through holes 40 through which the exhaust gas flows from inner collecting chamber 36 to second end body 14.

The gap between second disk-shaped element 38 and the end wall 14b of second end body 14 defines a chamber 48 permitting axial displacement of second disk-shaped element 38 caused by inevitable thermal expansion of cartridge 8 and the various component parts of device 1 during operation of device 1.

Second disk-shaped element 38 supports coaxially a projecting inner locating collar 42 and a projecting outer locating collar 43, which extend towards intermediate body 12, and in which is inserted a second end portion 8b of cartridge 8.

More specifically, the inner locating collar 42 is located at an inner annular portion of second disk-shaped element 38 externally surrounding holes 40; and the outer locating collar 43 is located at a peripheral annular portion of second disk-shaped element 38.

Locating collars 24, 25, 42, 43 retain cartridge 8 axially in the work position by means of a tie 44 coaxial with axis A and connected at opposite ends to disk-shaped

elements 20, 38 in known manner not described in detail.

Tie 44 is made of the same type of material, so as to undergo substantially the same thermal expansion, as nets 28, 30 of basket 26.

The path P traveled, in use, by the exhaust gas between inlet 4 and outlet 6 is shown by the bold line in Figure 1.

More specifically, the exhaust gas is fed into device 1 through inlet 4, and flows along inlet conduit 18 and through holes 22 in first disk-shaped element 20 into outer collecting chamber 34 surrounding cartridge 8, and the gradually decreasing annular section of which assists in forcing the exhaust gas radially through cartridge 8.

The purified exhaust gas then flows into inner collecting chamber 36, from there through holes 40 in second disk-shaped element 38 into second end body 14, and out through outlet 6.

According to the present invention, therefore, the exhaust gas initially occupying a concentrated cylindrical volume defined by inlet 4 is gradually caused to occupy a distributed annular volume defined by outer collecting chamber 34, so that, between inlet 4 and outer collecting chamber 34, most of the kinetic energy of the exhaust gas is dissipated as a result of the following three phenomena:

- distribution of the exhaust gas into a distributed volume at initial portion 18a of inlet conduit 18;

- expansion of the exhaust gas along end portion 18c of inlet conduit 18, where the gas passage section gradually increases; and

- the exhaust gas, as it distributed into outer collecting chamber 34, "skimming" along the inner surface of the chamber.

More specifically, as it is distributed into outer collecting chamber 34, the exhaust gas skims along the inner surface of the chamber, so that, by virtue of Stefan-Bolzmann's (black body) law, the temperature of the exhaust gas is stabilized to a certain extent by radiation towards maximum values of 400-500°C - much lower than those (650°C) of known devices in which the exhaust gas is fed into inner collecting chamber 36 - thus helping to maintain low reoxidation values of the sulfates in the exhaust gas.

Stabilizing the temperature of the exhaust gas towards maximum values of 400-500°C causes a reduction in the heat content of the system and in the specific volume of the exhaust gas as compared with known devices; which factors in turn reduce the impact speed of the exhaust gas against pad 32 of cartridge 8, thus reducing the kinetic energy of the exhaust gas in quadratic proportion to the reduction in speed.

By reducing the kinetic energy of the exhaust gas, radial travel of the exhaust gas through cartridge 8 from outer collecting chamber 34 to inner collecting chamber 36 is therefore less violent, and pad 32 subjected to

considerably less mechanical stress, as compared with conventional devices in which the exhaust gas travels outwards through the cartridge by expansion. As such, the average working life of the cartridges of devices according to the present invention is substantially independent of the application in which the devices are used.

Figure 3 shows a device for reducing atmospheric pollution by internal combustion engine exhaust gas in accordance with a second embodiment of the present invention.

Being substantially similar to device 1, the Figure 3 device, indicated as a whole by 1', will be described only insofar as it differs from device 1, and using the same reference numbers for parts similar or corresponding to those already described.

Device 1' differs from device 1 as regards the shape of the guide body, indicated 16', and hence the shape of the inlet conduit, indicated 18'.

More specifically, guide body 16' comprises a substantially conical first portion 16a' internally facing truncated-cone-shaped second portion 10b of first end body 10; and a substantially cylindrical second portion 16b', which extends integrally from first portion 16a', faces third portion 10c of first end body 10, and has a diameter substantially equal to the radially outer diameter of cartridge 8 (i.e. substantially equal to the radially inner diameter of outer collecting chamber 34).

In the flow direction of the exhaust gas from inlet 4 to outlet 6, inlet conduit 18' therefore comprises an initial portion 18a' - defined by truncated-cone-shaped portion 10b and conical portion 16a' - in which the exhaust gas passage section is substantially constant, is equal to the passage section defined by inlet 4, and has an increasing mean radius, measured with respect to axis A; and an end portion 18b' - defined by cylindrical portions 10c, 16b' - in which the gas passage section is substantially constant, is greater than that defined by portions 10b, 16a', and has a substantially constant mean radius.

Figures 4 and 5 show a device for reducing atmospheric pollution by internal combustion engine exhaust gas in accordance with a third embodiment of the present invention.

Being substantially similar to device 1, the Figure 4 and 5 device, indicated as a whole by 1", will be described only insofar as it differs from device 1, and using the same reference numbers for parts similar or corresponding to those already described.

Device 1" differs from device 1 as regards the shape of the first end body, indicated 10", and the shape of the guide body, indicated 16".

More specifically, first end body 10" is substantially cup-shaped and comprises a cylindrical lateral portion 10a" along an extension of intermediate body 12; and an end wall 10b" having an offset through

hole 50 (i.e. with an axis B parallel to and distinct from axis A) in which is fitted a cylindrical element 52 defining the exhaust gas inlet, indicated in this case by 4".

The gap between the end wall of first end body 10" and first disk-shaped element 20 defines an exhaust gas expansion chamber 54 in which part of the kinetic energy of the exhaust gas is dissipated by expansion.

Guide body 16" is of cylindrical tubular shape, and defines, with first end body 10", an annular-section gap, which communicates with expansion chamber 54 and, through holes 22, with outer collecting chamber 34, and defines an inlet conduit 18" for feeding the unpurified exhaust gas from expansion chamber 54 to outer collecting chamber 34.

More specifically, guide body 16" faces lateral portion 10a" of first end body 10", is separated axially from end wall 10b", and comprises a substantially cylindrical first portion 16a", and a truncated-cone-shaped second portion 16b" extending integrally from first portion 16a" and decreasing in diameter towards intermediate body 12.

In the flow direction of the exhaust gas, inlet conduit 18" therefore comprises an initial portion 18a" in which the exhaust gas passage section is substantially constant, is equal to the passage section defined by inlet 4, and has a substantially constant mean radius; and an end portion 18b" in which the gas passage section

increases and has a decreasing mean radius.

Device 1" operates in substantially the same way as device 1, except that, as opposed to flowing along the initial portion of inlet conduit 18", the exhaust gas is expanded inside expansion chamber 54 to dissipate most of the kinetic energy of the exhaust gas.

Figure 6 shows a device for reducing atmospheric pollution by internal combustion engine exhaust gas in accordance with a fourth embodiment of the present invention.

Being substantially similar to device 1", the Figure 6 device, indicated as a whole by 1"', will be described only insofar as it differs from device 1", and using the same reference numbers for parts similar or corresponding to those already described.

Device 1"' differs from device 1" solely as regards the position of the inlet, indicated 4"', with respect to axis A.

More specifically, as opposed to being formed in end wall 10b" of first end body 10" and having an axis B parallel to and distinct from axis A, inlet 4"' is formed in lateral portion 10a" of first end body 10" and has an axis C perpendicular to and skew with respect to axis A (i.e. not radial and not intersecting axis A).

More specifically, in lateral portion 10a" of first end body 10" and in first portion 16a" of guide body 16", two through holes 58 are formed coaxially with axis C and fitted inside with cylindrical element 52 defining inlet

4"'.

The distance between axes C and A is preferably greater than half the radius of lateral portion 10a" of first end body 10".

The exhaust gas therefore flows into expansion chamber 54 in a direction perpendicular to and not radial with respect to axis A, and flows, inside expansion chamber 54, along a circular path substantially tangent to the inner surface of guide body 16".

This therefore provides, as the exhaust gas expands inside expansion chamber 54, for dissipating a greater amount of kinetic energy as compared with device 1".

The advantages of the devices according to the present invention will be clear from the forgoing description.

Clearly, changes may be made to the devices as described and illustrated herein without, however, departing from the scope of the present invention.

For example, inlet 4"' of device 1"' may be positioned differently from that described, and in particular may be located with axis C perpendicular to and intersecting (i.e. radial with respect to) axis A.

CLAIMS

1) A device (1; 1'; 1"; 1"') for reducing atmospheric pollution by exhaust gas, comprising a casing (2) having an inlet (4; 4", 4"') for the unpurified exhaust gas, and an outlet (6) for the purified exhaust gas; and scrubbing means (8) housed in said casing (2), interposed between said inlet (4; 4"; 4"') and said outlet (6), and defining an inner chamber (36) and, together with said casing (2), an outer chamber (34) surrounding said scrubbing means (8); characterized by comprising first connecting means (18; 18'; 54, 18") for connecting said outer chamber (34) to said inlet (4; 4"; 4"'); and second connecting means (14) for connecting said inner chamber (36) to said outlet (6).

2) A device (1; 1') as claimed in Claim 1, characterized in that said first connecting means comprise an annular-section first inlet conduit (18; 18').

3) A device (1; 1') as claimed in Claim 2, characterized in that said first inlet conduit (18; 18') comprises at least a first portion (18a; 18a') having transverse dimensions increasing towards said outer chamber (34).

4) A device (1; 1') as claimed in Claim 3, characterized in that said first portion (18a; 18a') of said first inlet conduit (18; 18') has a substantially constant exhaust gas passage section.

5) A device (1; 1') as claimed in Claim 4, characterized in that the exhaust gas passage section of said first portion (18a; 18a') of said first inlet conduit (18; 18') is substantially equal to the exhaust gas passage section defined by said inlet (4).

6) A device (1; 1') as claimed in any one of Claims 3 to 5, characterized in that said first portion (18a; 18a') of said first inlet conduit (18; 18') is defined by a pair of conical walls (10b, 16a; 10b, 16a') increasing in diameter towards said outer chamber (34) and converging with each other towards the outer chamber (34).

7) A device (1; 1') as claimed in any one of Claims 3 to 6, characterized in that said first inlet conduit (18; 18') also comprises a second portion (18b; 18b') located downstream from said first portion (18a; 18a') and having a substantially constant exhaust gas passage section.

8) A device (1) as claimed in Claim 7, characterized in that the exhaust gas passage section of said second portion (18b) of said first inlet conduit (18) is substantially equal to the exhaust gas passage section of said first portion (18a).

9) A device (1') as claimed in Claim 7, characterized in that the exhaust gas passage section of said second portion (18b') of said first inlet conduit (18') is greater than the exhaust gas passage section of said first portion (18a').

10) A device (1; 1') as claimed in any one of Claims 7 to 9, characterized in that said second portion (18b; 18b') of said first inlet conduit (18; 18') is defined by a pair of cylindrical walls (10c, 16b; 10c, 16b') of substantially constant diameter.

11) A device (1) as claimed in any one of Claims 3 to 8, characterized in that said first inlet conduit (18) also comprises a third portion (18c) located downstream from said first portion (18a) and having an increasing exhaust gas passage section.

12) A device (1) as claimed in Claim 11, characterized in that said third portion (18c) of said first inlet conduit (18) is defined by a cylindrical outer wall (10c) and by a conical inner wall (16c).

13) A device (1"; 1"') as claimed in Claim 1, characterized in that said first connecting means (54, 18") comprise an exhaust gas expansion chamber (54).

14) A device (1"; 1"') as claimed in Claim 13, characterized in that said first connecting means (54, 18") also comprise an annular-section second inlet conduit (18") interposed between said expansion chamber (54) and said outer chamber (34).

15) A device (1"; 1"') as claimed in Claim 14, characterized in that said second inlet conduit (18") comprises at least a first portion (18a") having a substantially constant exhaust gas passage section.

16) A device (1"; 1"') as claimed in Claim 15, characterized in that the exhaust gas passage section of

said first portion (18a") of said second inlet conduit (18") is substantially equal to the exhaust gas passage section defined by said inlet (4"; 4"').

17) A device (1"; 1"') as claimed in Claim 15 or 16, characterized in that said first portion (18a") of said second inlet conduit (18") is defined by a pair of cylindrical walls (10a", 16a") of substantially constant diameter.

18) A device (1"; 1"') as claimed in any one of Claims 15 to 17, characterized in that said second inlet conduit (18") also comprises a second portion 18b") located downstream from said first portion (18a") and having an increasing exhaust gas passage section.

19) A device (1"; 1"') as claimed in Claim 18, characterized in that said second portion (18b") of said second inlet conduit (18") is defined by a cylindrical outer wall (10a") and by a conical inner wall (16b").

20) A device (1") as claimed in any one of Claims 13 to 19, characterized in that said casing (2) extends substantially along a first axis (A), and said inlet (4") has a second axis (B) substantially parallel to said first axis (A).

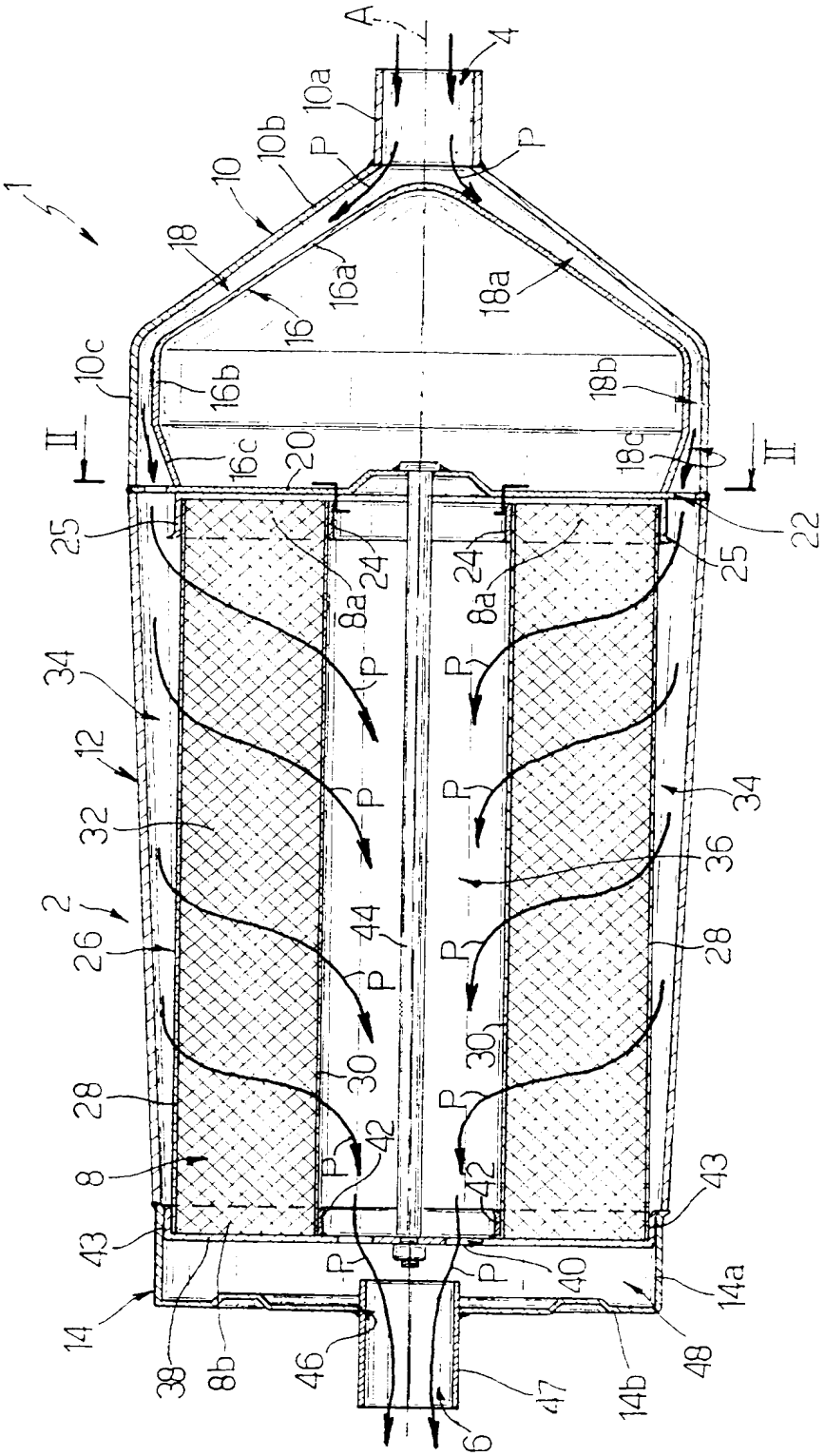
21) A device (1"') as claimed in any one of Claims 13 to 19, characterized in that said casing (2) extends substantially along a first axis (A), and said inlet (4"') has a third axis (C) crosswise to said first axis (A).

22) A device (1"') as claimed in Claim 21,

characterized in that said third axis (C) is perpendicular to said first axis (A).

23) A device (1"') as claimed in Claim 21 or 22, characterized in that said third axis (C) is skew with respect to said first axis (A).

24) A device (1; 1'; 1"; 1"') as claimed in any one of the foregoing Claims, characterized in that said outer chamber (34) has an annular section decreasing in the flow direction of the exhaust gas.


A
4
10a
10b
10
1
18
16a
18a
16
10c
16b
18b
II
16c
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25
22
24
8a
34
12
32
2
26
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14b
47
6

Fig.1

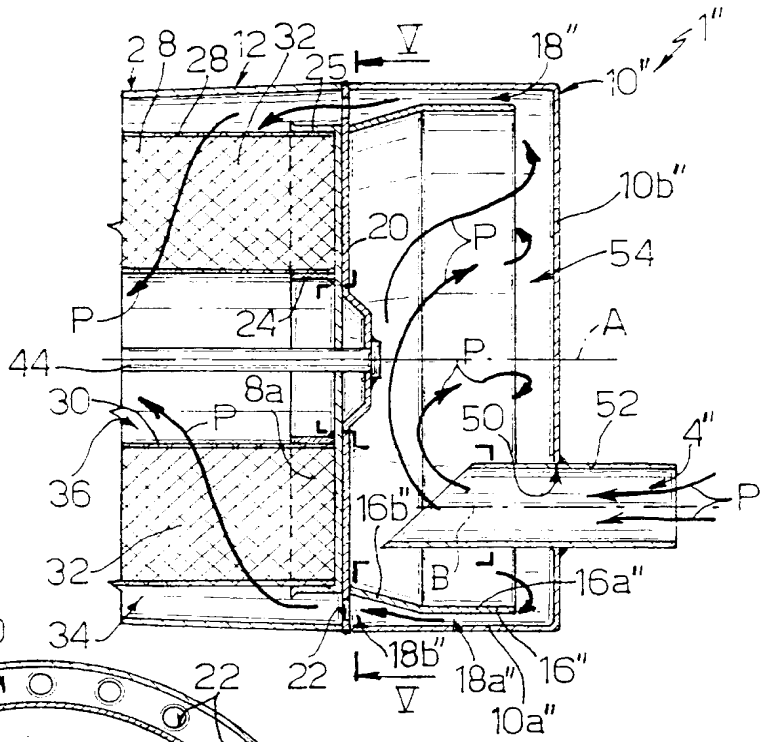


Fig.4

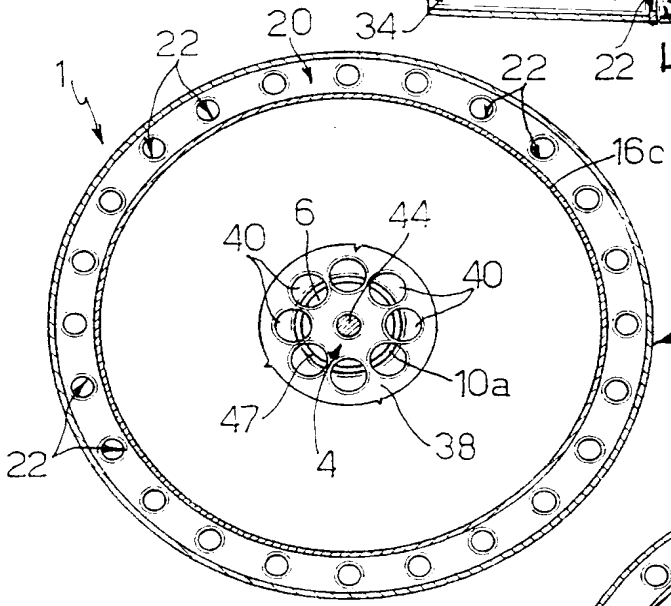


Fig.2

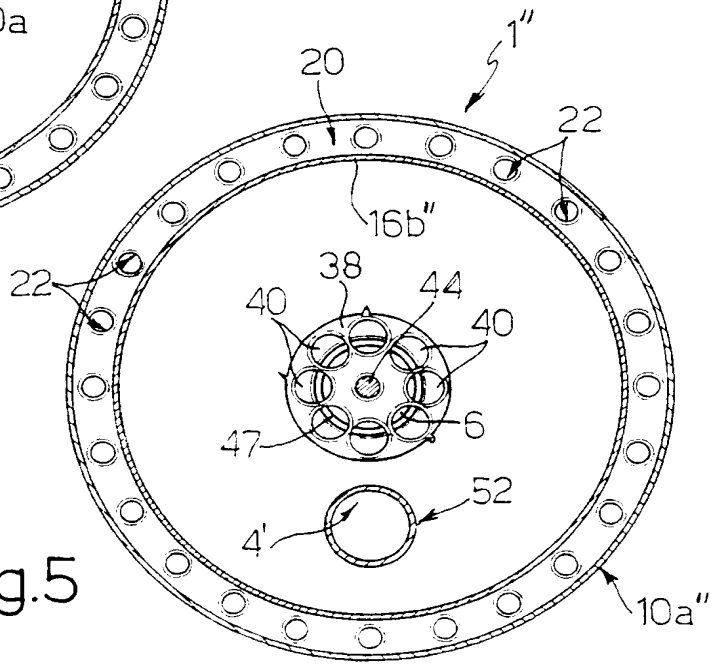
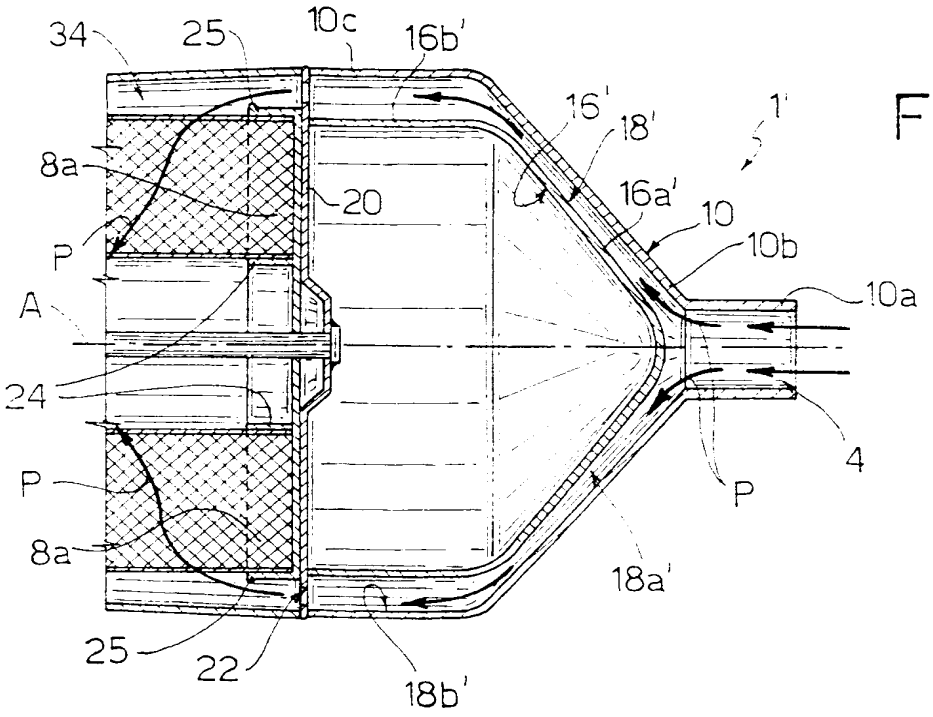


Fig.5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25
10c
16b'
16'
18'
1'
8a
20
16a'
10
10b
10a
P
A
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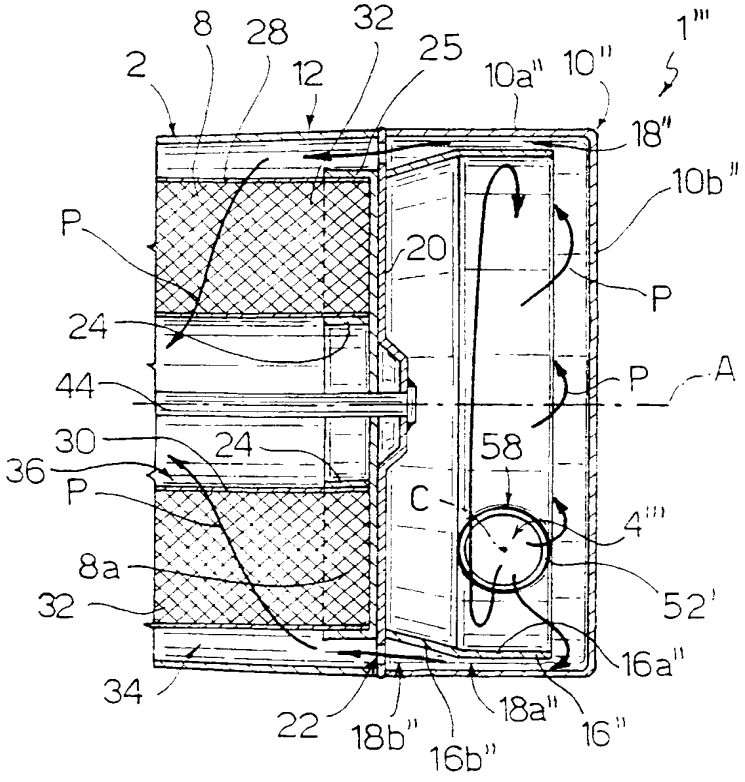
4
P
8a
18a'
25
22
18b'

Fig.3


8
28
32
2
12
25
10a"
10"
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18"
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24
P
A
44
30
24
58
36
P
C
4'''
8a
52'
32
16a"
34
22
18b"
16b"
18a"
16"

Fig.6